SCIENCE STANDARD 10

All students will gain an understanding of the structure, dynamics, and geophysical systems of the earth.

INTRODUCTION

This standard provides students with the skills and understanding needed to interpret their geophysical surroundings, explaining the origin and composition of the planet on which they live and the weather systems generated by a dynamic atmosphere.

They relate the nature of the Earth's crust to surface features that are readily observable. The geography and geology of New Jersey and the rest of the world is explained in terms of tectonic processes, mountain building, water erosion, glaciation, and changes in ocean level as learners acquire and use investigative skills to identify the effects of such processes anywhere on the globe.

The dynamic interrelationship between the ongoing changes in the planet's surface, its oceans, and its atmosphere is linked to a study of the Earth's climate and weather, including discussions of the impact of weather on human activities.

DEVELOPMENTAL OVERVIEW

In grades K-4, young children need a feel for their surroundings. By studying familiar locations, drawing maps, and experimenting with different types of maps, children become more fully aware of their neighborhoods and then their state, nation, and world. Such experimentation introduces students to symbolic representation and models.

Children need to understand where the materials in their world come from. In age-appropriate fashion, children are introduced to characteristics for identification and separation that can be applied to rocks and minerals. The existence and probable origin of various fossils are introduced as students observe and describe fossils of many different life-forms.

Using the concepts of properties and classification, students in the primary grades begin to observe water and its importance on the surface of the Earth. Because students are affected by weather, they are naturally interested in keeping and examining their own records of weather conditions.

By grades 5-8, the middle school years, students learn to create and use more types of maps, including a variety of map projections. For students in the middle grades, the study of the Earth sciences can introduce processes as well as long-term and large-scale changes. The study of weather becomes systematic and predictive. Earth science facts are related, and systems involving many components are introduced.

By grades 9-12, students develop abstract thinking skills, and more complex Earth science processes are introduced to help students explain their environment and the features of the Earth and its atmosphere. Students are expected to relate movements of the Earth's crust to observed surface features. Their understandings and interpretation of the socioeconomic impact of weather should draw upon the relationships among surface waters, oceans, atmospheric conditions, and weather phenomena.

DESCRIPTIVE STATEMENT

The study of science should include a study of the planet Earth and its relationship to the rest of the universe. This standard describes what students should know about the composition of the Earth and the forces that shape it, while *Science Standard 11* describes what students should know about astronomy and space science.

CUMULATIVE PROGRESS INDICATORS

By the end of Grade 4, students

1. Recognize and demonstrate the use of different kinds of maps.

2. Investigate materials that make up the Earth, including rocks, minerals, soils, and fossils, and how they are formed.

3. Identify major sources and uses of water, discussing the forms in which it appears.

4. Collect and record weather data to identify existing weather conditions, and recognize how those conditions affect our daily lives.

Building upon knowledge and skills gained in the preceding grades, by the end of Grade 8, students

5. Compare different map projections, and explain how physical features are represented on each.

6. Identify the major features of the Earth's crust, the processes and events that change them, and the impact of those changes on people.

7. Identify the age of fossils, and explain how they provide evidence that life has changed through time.

8. Describe and explain the causes of the natural processes and events that shaped the Earth's surface and interior.

9. Monitor local weather conditions and changes in the atmosphere that lead to weather systems.

10. Investigate the composition, cycling, and distribution of the world's oceans and other naturally occurring sources of water.

Building upon knowledge and skills gained in the preceding grades, by the end of Grade 12, students

11. Use the evidence provided by topography, fossils, rock stratification, ice cores, and radiometric data to investigate the earth's changes.

12. Use the theory of plate tectonics to explain the relationship among earthquakes, volcanoes, mid-ocean ridges, and deep sea trenches.

13. Explore how weather phenomena and human activity are interrelated.

14. Identify and explain factors that influence water quality needed to sustain life.

LIST OF LEARNING ACTIVITIES FOR STANDARD 10

GRADES K-4

Indicator 1:

GRADES K-2
Maps as Representations of Real Things
Map Scavenger Hunts!
Representing Shapes on Maps

GRADES 3-4
Edible Map
Computer Map (Inedible)
New Jersey Road Map
Kinds of Maps

Indicator 2:

GRADES K-2
Rocks and "Nonrocks"
Breaking Rocks

GRADES 3-4
Fossil Imprints
Making Sandstone
Sorting Beach Objects
Rocks for Sale!
Classifying Minerals
Growing Crystals
Observing Soil

Indicator 3:

GRADES K-2
Water-Cycle Plays
Forms of Water
Family Water Use

Condensation
Earth, a Water Planet

Indicator 4:

GRADES K-2
Day-to-Day Weather

GRADES 3-4
Weather Station
Daily Weather Journals

GRADES 5-8

Indicator 5:

GRADES 5-6
Map Projections
Map Cutouts

GRADES 7-8
3-D Topographic Map

Indicator 6:

GRADES 5-6
Hallway Mural
Sands from around the World

GRADES 7-8
Coastline Maps and Models
Historic Maps
Rate and Time

Indicator 7:

GRADES 5-6
Fossils over Time

GRADES 7-8
Correlation of Rocks via Fossils
Decay Simulation
Fossils and Sedimentation Estimates

Indicator 8:

GRADES 5-6
Earthquake Model

GRADES 7-8
Volcanism and Diastrophism
Finding the Epicenter

Indicator 9:

GRADES 5-6
Weather Journal
Dew and Frost
Internet Weather

GRADES 7-8
Weather Forecasting
An Approaching Low

Indicator 10:

GRADES 5-6
Density Currents
Upwelling and Downwelling

GRADES 7-8
Ocean Surface Currents
Seawater Composition

GRADES 9-12

Indicator 11:

Ice Bubbles
Stratigraphy
Sedimentation

Indicator 12:

Plate Puzzle
Plate Edges

Indicator 13:

Snow Removal
Hurricanes and Major Storms

Indicator 14:

Water Quality
Nonpoint Source Pollution

Indicator 1: Recognize and demonstrate the use of different kinds of maps.

LEARNING ACTIVITIES: Grades K-2

Maps as Representations of Real Things. This activity helps students understand that maps are symbolic representations of real things. Students first explore and carefully study their classroom. Then, using blocks, cartons, cardboard, or any appropriate material, they build a three-dimensional model of the room. Next, they create a two-dimensional map of their model to represent the real objects by drawing symbols on the map. Students can use this same process to create maps of their playground or school, a city block, or their neighborhood.

Related Science Standards: 2, 5
Related Workplace Readiness Standards: 2.8, 3.1, 3.2, 3.15, 4.2, 5.3, 5.7, 5.8

Map Scavenger Hunts! To prepare for this activity, hide some objects in the classroom (or playground), and create a map that includes locations of the hidden objects. Using these maps, students look for the objects in pairs or small groups.

Later, students hide some objects themselves and create a new map with the locations of these objects marked. They challenge their partner or another group to search for the hidden objects using the new map.

Related Science Standards: 2, 4
Related Workplace Readiness Standards: 2.9, 3.9, 3.15, 4.2, 4.9, 5.4, 5.7

Representing Shapes on Maps. Students observe large objects in the classroom, such as desks, tables, and other pieces of furniture. Students associate shape with the surfaces of the objects. For example, a desk may have a rectangular top surface or a square side, while a tabletop might be round. Cut these surfaces out of sponges. Student groups, each working with a large sheet of paper that represents the classroom floor, then put the sponge shapes in the correct places on their classroom "map." The classroom objects can be moved, and the students can then modify their maps. Students can make their maps permanent by dipping the shaped sponges in washable paint and printing these shapes on the map.

Related Science Standards: 2, 4
Related Workplace Readiness Standards: 2.9, 3.9, 3.15, 4.2, 4.9, 5.4, 5.7

LEARNING ACTIVITIES: Grades 3-4

Edible Map. In this activity, students create an edible map of the state of New Jersey. Using baked pizza dough or plain sheet cake, student groups first create the basic shape of New Jersey. Using toppings such as colored icing, sprinkles, or small vegetable pieces, students represent the state's geographical and political features, including mountains, rivers, lakes, cities, towns, highways, and the state capitol.

Computer Map (Inedible). Students can use computer software to make maps of their bedroom, their route to school, a shopping mall, or a local store. Students exchange their community maps and write stories or directions using these maps.

Related Science Standards: 2, 5
Related Workplace Readiness Standards: 1.2,1.7, 2.8, 3.1,3.9,3.15,4.2,4.10

New Jersey Road Map. Student groups each receive a large road map of New Jersey. The students first trace familiar routes to historic landmarks, shopping malls, vacation destinations, etc. The students then look for the roads to geographical and geological features such as

- roads through a water gap
- roads paralleling mountain ridges
- roads winding alongside a meandering river

Students compare the location and direction of these roads to that of the natural feature. They create models or diagrams illustrating the correlation between human activity and natural surface features. Encourage students to relate their discoveries in journal entries, written reports with actual photographs, or computer multimedia presentations.

Related Science Standards: 2, 5
Related Workplace Readiness Standards: 1.2, 1.7, 2.8, 3.1, 3.9, 3.15, 4.2, 4.10

Kinds of Maps. Through this activity, students become aware that maps have specific purposes and uses. From newspapers, magazines, CD-ROMs, or the Internet, the students collect many different kinds of maps, including as the following:

- road maps
- weather maps
- political maps
- star maps
- hiking maps

Students study how these maps are used by interviewing people using specific maps, noticing how people use maps, or by using the maps themselves. Next, they create their own specialized map and ask a partner to use it. For example, one person can make a map of classmates' neighborhoods. Then that student can ask the partner to find his/her own house on the map.

Related Science Standards: 2, 5
Related Workplace Readiness Standards: 1.2, 1.7, 2.8, 3.1, 3.9, 3.15, 4.2, 4.10

Indicator 2: Investigate materials that make up the earth, including rocks, minerals, soils, and fossils, and how they are formed.

LEARNING ACTIVITIES: Grades K2

Rocks and "Nonrocks." In this activity, students discover some differences between rocks and "nonrocks" displayed around the classroom.

- The *rocks* are typical of specimens found throughout New Jersey and should have very obvious characteristics.
- The *nonrocks* should be equally obvious (e.g., bricks, cinder blocks, and sidewalk pieces).

Students compare and classify the objects as rocks or nonrocks. Students then choose their favorite rock and examine it closely for touch, feel, color, etc. A magnifying glass or hand lens can provide a closer look. Ask the children to choose words to describe the rocks, and write them on the chalkboard. Encourage students to describe where they think their rock was found.

Related Science Standards: 1, 2, 5
Related Workplace Readiness Standards: 2.8, 3.1, 3.3, 3.8, 3.9, 4.2, 5.1, 5.4, 5.7

Breaking Rocks. Students discover that some rocks can be broken apart. In this exercise, student groups receive plastic jars with lids, rock samples, squares of white cloth, and a container of water. (Be sure that at least one type of rock breaks easily.) Students place small pieces of rock into each jar, add some water to cover the rocks, and put on the lid. The students should designate one jar as a "control" and leave it unshaken. They should shake all the other jars hard for awhile. This shaking simulates rocks tumbling in a stream or rocks being pounded by waves at a shoreline. After shaking the jars, the students remove each lid and replace it with a cloth square fastened with a rubber band. Then they pour off the water used in the shaking. As the students examine rocks and the cloth, they try to answer the following questions:

- How have the rocks changed?
- Is there anything on the cloth surfaces?
- If so, where did the material come from?
- How do the surfaces of the cloths compare to that of the control?

Related Science Standards: 1, 2, 5
Related Workplace Readiness Standards: 2.8, 3.1, 3.3, 3.7, 3.12,3.13, 4.2, 5.4, 5.5, 5.7

LEARNING ACTIVITIES: Grades 34

Fossil Imprints. Students simulate how evidence of past life (*fossils*) was retained in rocks. They first examine real fossils, especially those that are imprints into rock. Students next collect shells, leaves, and other objects and press them into soft clay or wet plaster of Paris, leaving marks and imprints. Leaves can even be left behind. Using watercolors, students can paint the resulting "fossiliferous sedimentary rock" (if plaster of Paris is used) to make the simulations look real.

Making Sandstone. How do some rocks form? In this activity, students simulate the creation of *sandstone*, a type of sedimentary rock. Students pour a supersaturated salt solution into a small paper cup that contains some sand—and then set the cup aside. Students record their daily observations in journal entries. When the ingredients in the cup are completely dry, students can peel the paper away to reveal sand grains cemented together in newly formed "sandstone."

Related Science Standards: 1, 2, 5
Related Workplace Readiness Standards: 3.1, 3.3, 3.7, 3.12, 3.13, 4.2, 5.4, 5.5, 5.7

Sorting Beach Objects. Students receive a bucket containing sand and objects typically found on a beach. Using simple sieves (or their hands), they sift out the objects from the sand. The students then classify their beach objects by sorting them into groups based on similar properties, e.g., size, color, composition, and origin (natural vs. synthetic). Then ask them to sort their beach objects again, but in a different way.

If they haven't yet done so, ask the students to sort their beach objects into two groups: LIVING (or a shell, exoskeleton, or egg case produced by a living thing) or NONLIVING. They continue by sorting the NONLIVING category into groups until they have a group of rocks. They sort the rocks by their properties (e.g., color, texture, appearance, size, and shape). Finally, they draw pictures of the rocks in their classified groups and label the groups using the property by which the rocks were sorted.

Related Science Standards: 2
Related Workplace Readiness Standards: 3.5, 5.2, 5.5, 5.6, 5.8

Rocks for Sale! Students set up a "rock store" in which they display and try to sell rocks that they have collected. Alternately, they can use rock specimens from a classroom supply of New Jersey rocks.

Before they display their rocks, they must first sort them into various categories (based on softness, texture, composition, type, etc.). Students then arrange their wares and write descriptions of the rocks to use in computer-generated advertisements. Using classroom-made scrip or play money, the students conduct a "rock sale," count their scrip, and determine their "profits."

Related Science Standards: 1, 2, 5
Related Workplace Readiness Standards: 2.8, 3.1, 3.3, 3.8, 3.9, 4.2, 5.1, 5.4, 5.7

Classifying Minerals. Students place a group of minerals in a pile on a large piece of butcher block or mural paper and draw a circle around the pile of minerals. Ask the students to divide the group of minerals using *one* property. Suggest that the students consider the following properties:

- color
- luster
- texture
- hardness
- reaction to vinegar
- color yield in a streak test
- magnetism

For example, if *color* is the property, the students separate all of the minerals into two groups: light and dark. They place each new group near the original circle, draw circles around the new groups, and connect them with lines going to the original circle. Next, ask the students to divide each small group into even smaller groups using a *different* property, place them in a nearby spot on the large paper, and circle these groups. Students continue observing properties and classifying until each mineral has a circle around it. This activity helps students realize that every type of mineral has its own unique set of properties.

Related Science Standards: 1, 2, 5, 8
Related Workplace Readiness Standards: 2.2, 3.1, 3.2, 3.7, 3.8, 3.9, 3.11, 3.12, 3.13, 4.2, 5.4, 5.7, 5.8

Growing Crystals. Minerals are frequently found as part of the Earth's crust—either alone or within rocks. Minerals may form beautiful crystals. To acquaint themselves with minerals and crystals, students examine some real minerals and their crystal forms and locate photographs of missing varieties. They read science catalogs. Then students grow crystals using sugar and water, Epsom salts and water, or kosher salt and water. They set up experiments to discover which conditions are optimal for growth. They report their findings to the class.

Related Science Standards: 1, 2, 5
Related Workplace Readiness Standards: 3.1, 3.3, 3.7, 3.12, 3.13, 4.2, 5.4, 5.5, 5.7

Observing Soil. Ask the students, "What materials make up soil?" Encourage them to propose possible components of soil. Then the students collect soil samples outside. (Alternatively, you can simulate soil by combining commercially available soil mixtures.) Students examine their soil samples by spreading their material on a piece of white paper. Using a hand lens and tweezers or a simple probe (such as a toothpick), they separate the soil samples into groups such as:

- coarse materials (small stones or large, stony grit)
- fine materials (fine sand and clay)
- organic matter (decomposed leaves and twigs)

The students can relate their findings to their classmates. Students may extend this activity by letting their samples dry and then adding the samples to clear cups containing some water. They observe what happens when the mixture components settle. Students can further extend this investigation by comparing the composition of soils from different locations around the state and from different depths in the ground.

Related Science Standards: 1, 2, 5
Related Workplace Readiness Standards: 3.1, 3.3, 3.7, 3.12, 3.13, 4.2, 5.4, 5.5, 5.7

Indicator 3: Identify major sources and uses of water, discussing the forms in which it appears.

LEARNING ACTIVITIES: Grades K-2

Water-Cycle Plays. Student groups create and act out stories about the water cycle. Using some type of costuming or pictures on craft sticks, the students depict the travels of a water droplet through the water cycle, e.g.,

- A raindrop forms in a cloud and falls on a hill.
- It runs into a stream, which flows into a river, a bay, and the ocean.
- It evaporates and goes into a cloud, and the cycle continues.

Play audiotapes of environmental sounds (e.g., rain, rushing streams, or waves on a beach) while students act out their plays.

Help students realize that some water is "held up" in lakes, aquifers, and puddles and so is not flowing through the water cycle. Discuss with them how water is used by plants and animals (including humans). Students can collect pictures of how people use water and create a classroom display.

Related Science Standards: 1, 2, 4, 5
Related Workplace Readiness Standards: 2.2, 2.8, 3.13.8, 3.12, 3.15, 4.2, 5.7

Forms of Water. Students pour some water into a clear container, then mark how high the water level is. They observe what the water looks like in its liquid state. They then freeze the water until it is completely solid. Ask students to predict what will happen to the volume (height) of the water. They can draw pictures or write journal entries to show their predictions. The students observe the ice to see how the water has changed in appearance and size.

After marking the level of the ice, the students lightly cover the cups with plastic wrap (to prevent evaporation) and let the ice melt completely. They again observe the water and its volume. They compare the volume of the water in the liquid state before and after it was frozen.

Students discuss occasions when they have noticed that water seemed to disappear. They then fill two cups with water and cover only one cup with plastic wrap. They place both cups of water on a windowsill. The students observe and record the height of the water in each cup daily. What is happening to the water? Where has it gone?

Related Science Standards: 2, 5, 8
Related Workplace Readiness Standards: 2.7, 3.2, 3.3, 3.6-3.9, 3.12, 4.2, 5.7

Family Water Use. Students are rarely aware of how much water their own family uses. In this activity, students investigate and list ways their family consumes water daily and weekly. To visualize the amounts, students can fill buckets or gallon jugs with water and move them from one location to another.

Students can make story booklets and/or multimedia presentations relating the results of their study. Older students might analyze their results using graphs and other mathematical ways of summarizing the data.

Related Science Standards: 1, 2, 4, 5, 12
Related Workplace Readiness Standards: 2.2, 2.8, 3.13.8, 3.12, 3.15, 4.2, 5.7

LEARNING ACTIVITIES: Grades 3-4

Condensation. Give groups of students clear plastic cups partially filled with warm tap water. The students cover the cups with plastic "cling" wrap. For several minutes, they observe any changes in the appearance of the plastic film and record these changes with drawings, journal entries, etc.

At the end of four or five minutes, students place an ice cube on top of the plastic film covering the cup. Students record what they observe at regular five-minute intervals. Ask the students questions such as the following:

- What did you see on the underside of the plastic film as time went by?
- How did the water droplets get there?
- Where else have you seen water collect on surfaces?

Guide students into thinking about the occasions when they observe water and other moisture in their surroundings.

Related Science Standards: 1, 2, 4, 5
Related Workplace Readiness Standards: 2.22, 2.8, 3.1, 3.8, 3.12, 3.13, 3.15,4.2, 5.7

Earth, a Water Planet. Students estimate the percentage of the Earth's surface that is covered by water. Using a transparent grid overlay, students count the number of grid squares that cover land and the number of grid squares that cover water. They build and use graphs and tables to summarize their individual and class findings. They estimate the ratio of water surface to land surface or the percentage of water coverage (which they can find by dividing the number of water squares by the total number of squares).

Alternately, students can use a globe or a map and count the number of squares formed by longitude and latitude lines that are mostly water and those that are mostly land. What is the difference? What is the percentage of Planet Earth that is covered with water?

Related Science Standards: 1, 2, 4, 5
Related Workplace Readiness Standards: 2.2, 2.8, 3.1, 3.8, 3.12, 3.13, 3.15, 4.2, 5.7

Indicator 4: Collect and record weather data to identify existing weather conditions, and recognize how those conditions affect our daily lives.

LEARNING ACTIVITIES: Grades K-2

Day-to-Day Weather. Students realize that weather is all about them and influences their lives on a daily basis. From magazines and catalogs, students cut out pictures that represent daily weather conditions and pictures of various types of clothing suitable for different weather situations. Each day, they choose from this collection those pictures that correspond to the day's weather. For example, on a rainy day, students may select pictures of rain and rainy-day apparel such as raincoats, umbrellas, and even galoshes. They display the pictures in the class weather center and orally report the day's weather to the class. The students keep a weather journal containing drawings or pasted pictures.

Related Science Standards: 1, 2, 4, 5
Related Workplace Readiness Standards: 2.2, 2.8, 3.1, 3.8, 3.12, 3.13, 3.15, 4.2, 5.7

LEARNING ACTIVITIES: Grades 3-4

Weather Station. Students establish a class weather station using homemade or basic instrumentation such as a thermometer, barometer, rain gauge, wind vane, and anemometer.

Daily Weather Journals. Students write daily weather conditions in their weather journals. Entries might include

- readings from the instrumentation in their class weather station
- observations regarding cloud types, condition of air, amount and kind of precipitation
- present weather conditions obtained from a weather center (e.g., radio, television, or Internet)

In their journal entries, students could also write about the type of clothing they could wear outdoors and what activities they could do that day.

Students examine their data and learn to recognize certain patterns of seasons (e.g., storms vs. fair weather). Challenge students to examine their data more closely by asking them if there is any connection between their barometer readings and the prevailing weather conditions. The students can create video or multimedia presentations reporting their discoveries.

Related Science Standards: 1, 2, 4, 5
Related Workplace Readiness Standards: 2.2, 2.7-2.9, 3.1, 3.8, 3.12-3.15, 4.2, 5.4

Indicator 5: Compare different map projections, and explain how physical features are represented on each.

LEARNING ACTIVITIES: Grades 5-6

Map Projections. Students, organized into cooperative learning groups, gain insight into the characteristics that separate one kind of map projection from another. In classrooms equipped with videodisc players, multimedia computers, and reference materials, student groups retrieve information about gnomonic projections, cylindrical projections, and conic projections. They summarize their findings in a portfolio.

When given unlabeled sets of projections, students sort, identify, and explain uses of these projections.

Related Science Standards: 2, 4, 5
Related Workplace Readiness Standards: 3.8, 3.9, 3.14

Map Cutouts. Students examine two or more world maps produced by different projections and investigate how area is represented on these maps. From each map, they cut out Iceland, Mexico, Brazil, Australia, and Africa. Then they weigh each cutout with a sensitive balance. For each set of pieces from a projection, they use calculators to find the ratio of the weight of each compared to that of the Africa cutout. Next, students find the actual land areas for the countries and continents using an atlas or other source. They then calculate the ratio of the actual area of each country to that of Africa.

Students describe the effect on apparent area of the different projections. After doing related reading, they propose reasons for using projections that may produce distortions in apparent area.

(Alternatively, students can weigh the complete set of cutouts from a given map and compare their combined weight to that of a set of cutouts from a different map.)

Related Science Standards: 2, 5
Related Workplace Readiness Standards: 3.8, 3.9, 3.14

LEARNING ACTIVITIES: Grades 7-8

3-D Topographic Map. Students first examine topographic maps used in "real life"—e.g., maps used by people hiking the Appalachian Trail in New Jersey.

To help visualize the third dimension of contour/topographic maps, students create a 3-D model of an actual quadrangle. They first obtain basic topographic maps of Mount Saint Helens before and after its famous 1980 eruption. Working in pairs, one pupil creates the pre-eruptive mountain while the partner generates a post-eruptive model. Each student creates templates at selected levels of elevation on their maps, transfers the templates to corrugated cardboard, traces them, cuts them out, and glues them one layer on another to reconstruct the map in a third dimension. Each partner explains to the other how contour lines actually show shape and elevation at the same time. Holding the models up for edge-on viewing helps the students picture the original interpretation of the initial contour/topographic map.

Students examine stereograms of contour maps to visualize a 3-D interpretation of the isolines known as contour lines. Ask the students questions such as the following. How do lines indicate mountaintops, depressions, valleys, steepness, and flatness? Which way is downstream?

Related Science Standards: 2, 5
Related Workplace Readiness Standards: 1.1, 3.2, 3.7

Indicator 6: Identify major features of the earth's crust, the processes and events that change them, and the impact of those changes on people.

LEARNING ACTIVITIES: Grades 5-6

Hallway Mural. In this class project, students create a pictorial representation of major features of the Earth's crust as well as examples of weathering and erosion. From old magazines, the Internet, or CD-ROMs, students obtain pictures of crustal features such as mountains, volcanoes, canyons, plains, and plateaus. They also find examples of the natural processes of weathering and erosion that tear the solid earth down (including glaciers and glaciated areas, landslides and mud slides, and running water). Students place their collection of materials on a hallway mural. Ask them to imagine the West Coast of the United States on the left, the East Coast on the right, and features of the middle of the country in between the coasts. Students can add sketches and drawings of specific places to the mural.

Back in the classroom, students discuss different features of the Earth's crust, the processes of weathering and erosion that change the crustal features, and how those changes impact the life and ecology of the region.

Related Science Standards: 1, 2
Related Workplace Readiness Standards: 1.1, 2.3, 2.6, 3.2, 3.5, 3.15, 4.2, 4.3, 4.9

Sands from around the World. Students discover that they can learn the geologic history of a region by studying its beach sand. Using their eyes, hand lenses, or stereoscopic microscopes, students examine sands from many different beaches. They study properties such as composition, color, luster, texture, and grain size and shape. They record their observations in drawings and written notes.

Students then place their sand samples on a world map. They find common features in specific groups of sands. For example, they may study sands common to a geographic region, such as New Jersey or the East Coast of the United States. They may study lake or river sands, sands that are close to a particular mountain range, or sands that are predominantly a specific color.

Students learn that sand grains are tiny pieces of minerals, rocks, and shells that have been produced by weathering and erosion, and that the older grains are smaller and more rounded than the younger ones. The students use resource materials and their observations of the sand samples to determine possible origins of the sand samples. For example,

- Sands from the East Coast of the United States are composed mostly of quartz—an abundant, hard mineral originating in the Appalachian Mountain Range.
- Many black sands are volcanic in origin.
- The sands of island beaches are characterized by shell and coral fragments.

Related Science Standards: 2, 4, 5, 8
Related Workplace Readiness Standards: 2.2, 3.1-3.4, 3.7, 3.8, 3.12, 3.13, 4.2, 5.4, 5.7

LEARNING ACTIVITIES: Grades 7-8

Coastline Maps and Models. Using available resources (e.g., CD-ROMs, videodiscs, computer software, texts, and other publications), students investigate the characteristics of shorelines and the processes of weathering and erosion that change shorelines. After this review, students obtain maps (quadrangles) of Boothbay, Maine; Point Reyes, California; and Toms River, New Jersey. They examine the coastlines on these quadrangles, looking for answers to questions such as the following:

- Which coastlines are submergent? Emergent?
- Where are sandbars? What types are visible?
- What is a barrier island?

- How do ocean waves change a coastline?
- What erosional features are found along coastlines?
- How are the coastlines similar? How are they different?
- How do humans try to lessen the impact of waves and currents on shorelines?

Students set up stream tables. Using a mix of fine sand, coarse sand, and some gravel, they create a continent with a shoreline at one end of the tank. They add water to simulate an ocean:

- Waves striking the shoreline change its shape.
- Currents flowing by the shoreline also change it.

Students place groin and other impediments to erosion and watch for results. Afterward, students relate their modeling to their map studies.

Related Science Standards: 1, 2, 4
Related Workplace Readiness Standards: 1.1, 2.3, 2.6, 3.2, 3.5, 3.15, 4.2, 4.3, 4.9

Historic Maps. Erosion and transport of geologic material may only become significant over long periods of time. Students examine a series of historic maps (e.g., from the early, middle, and late 19th and 20th centuries) to study these natural processes and the effect of man-made structures on them. They use historic maps as a resource for studying changes such as the following:

- River sedimentation, delta building, and the effects of levees on these natural processes (using historic maps of New Orleans and the Mississippi Delta)
- The effects of waterborne sand movement and human intervention (using historic maps of Long Island, Sandy Hook, or New Jersey barrier islands)

Students present their findings in written or multimedia reports. Challenge them to predict future effects of erosion and transport of geologic material.

Related Science Standards: 1, 2, 4
Related Workplace Readiness Standards: 1.1, 2.3, 2.6, 3.2, 3.5, 3.15, 4.2, 4.3, 4.9

Rate and Time. Students study historic water erosion by using a topographic map of a feature formed by water erosion (e.g., the Grand Canyon, Niagara Falls, and the Hudson Canyon). They estimate a rate of erosion associated with the feature and then estimate the *time* it took for the feature to form. Students compare their estimates with authoritative estimates from stratigraphic data.

Challenge students to predict how such effects might produce changes to the Earth's crust in the distant future. They could present these predictions using drawings, maps, essays, and/or computer multimedia presentations.

Related Science Standards: 1, 2, 5
Related Workplace Readiness Standards: 2.6, 3.5, 3.9, 3.12

Indicator 7: Identify the age of fossils, and explain how they provide evidence that life has changed through time.

LEARNING ACTIVITIES: Grades 5-6

Fossils over Time. Student groups examine different sets of identified fossils that are representative of life during a particular period of geologic time. The students draw sketches of the fossils and determine the time and environment in which the organisms lived. They use CD-ROMs, videotapes, laser videodiscs, computer software, and other resources to learn about the life-forms represented by the fossil collection.

Student groups construct dioramas or create multimedia presentations that picture life during a particular period or era of geologic time. Students review the work of other groups to recognize how life has changed during the ages of geologic time. They can present their findings orally, in written form, or technologically through multimedia programs.

Related Science Standards: 1, 2
Related Workplace Readiness Standards: 1.1, 2.6, 2.7, 2.9, 3.5, 3.15, 4.2

LEARNING ACTIVITIES: Grades 7-8

Correlation of Rocks via Fossils. In this activity, students correlate rock strata from three locations through the identification of fossils found within each layer of rock. Explain to students the concept of correlation, a technique in which sets of rock layers are related positionally by age through the examination of the fossils contained in those layers.

Prepare the "puzzle" pieces that the students will correlate by following these steps:

- Create three columns that represent a cross section of rock layers "spanning" geologic time.
- Place sketches of fossils of the same time on the same level across the columns.
- Cut up the columns (separately) into puzzle pieces of one, two, three, or four layers.

Students rebuild the columns based on cross-referencing fossils and rock types. They then relate the fossils to a detailed geologic timescale that helps them realize how forms of life have changed over time.

Related Science Standards: 1, 2, 5
Related Workplace Readiness Standards: 3.1, 3.2, 4.3

Decay Simulation. Introduce the students to the concepts of simulation and the random nature of radioactive decay. Without using actual radioactive materials, students simulate radioactive decay by working in pairs using a large set of 12-sided dice or working as an entire class using two cubic dice per student.

- Students roll dice (representing atoms) and remove any 1s (atoms that have decayed).
- They count and record the number of dice remaining after the decayed atoms (the 1s) have been removed. (The counting represents the determination of the number of radioactive atoms remaining in the rock or fossil.)
- They continue this for 10 sets of rolls of the dice. (Each roll of the dice represents a constant time interval.)
- They graph the number of "atoms" remaining after given amounts of "time."

Students use their results to model finding a time interval (number of rolls of the dice) if the percent of radioactive atoms (dice) remaining is known. They can use the dice analogy to describe the radioactive dating of a specific sample using a specific radioisotope. Students can also find the "half-life" for the "decaying" dice or use computer software to graph the data and find an equation for the percentage of "atoms" remaining after a given time interval.

Related Science Standards: 2, 5
Related Workplace Readiness Standards: 2.8, 3.2, 3.9

Fossils and Sedimentation Estimates. As students study the age of fossils, they encounter the idea that some fossils may be dated using the age of the sedimentary rock in which they are found. Students examine samples of sedimentary rock and begin to propose a model for the laying down of sediment and the eventual transformation of sediment into rock (*lithification*). They visit a sedimentary formation or view photographs of one. Using their understanding of sedimentation and rock formation processes, the students estimate the total time required to lay down the sedimentary formation. They also consider the subsequent processes that brought the formation to its current condition. By associating time intervals with each part of the process, the students propose an estimated age for fossils that may be found in the observed formation. They then consult authoritative resources for the age of the observed outcrop and any fossils found in it and analyze the sources of error in their own attempt at estimating age.

Related Science Standards: 2, 5
Related Workplace Readiness Standards: 3.5, 3.8, 3.12

Indicator 8: Describe and explain the causes of the natural processes and events that shaped the earth's surface and interior.

LEARNING ACTIVITIES: Grades 5-6

Earthquake Model. As students read about and see videos of earthquakes, they become interested in the motions of the Earth's surface that produce earthquakes. Simulate these motions using sheet cakes baked in foil baking pans following the procedure outlined below.

- Cut a sheet-cake pan in half and keep it together with aluminum foil wrapped around the bottom and up over the edges.
- Place this pan in a second pan to provide a sturdy container for baking.
- Bake the cake using the directions provided with the cake mix and let it cool.
- Gently lift the pan-foil container from the uncut pan. (Be careful not to bend or break the cake!)
- Place the cake on a work surface and remove the foil.

Use the cake in the cut pan to model Earth's motions. Explain to the students that the deformation of the cake is analogous to the deformation of the Earth's surface. (Use a separate cake for each motion that is modeled.)

- *Divergent or rifting motions of crustal blocks*—Gently pull apart the two halves of a cake.
- *Lateral plate motion*—Gently move one half of the cake to the left along the cut in the pan while moving the other half to the right.
- *Compression effects*—Gently push the two halves together.

During each simulation, students should make careful observations and record them with sketches and written descriptions. Using images from video or CD-ROM sources, they compare these simulated earthquake effects to those produced by actual earthquakes.

Related Science Standards: 1, 2
Related Workplace Readiness Standards: 2, 3, 3.4, 4.1, 4.2, 4.6, 4.7, 4.9, 4.10, 4.12, 4.15, 5.1, 5.2, 5.4, 5.5, 5.8

LEARNING ACTIVITIES: Grades 7-8

Volcanism and Diastrophism. Students examine posters, photographs, models, videotapes, and multimedia computer software that depict the effects of

- *Diastrophism*—folding and faulting
- *Volcanism*—the movement and cooling of magma (which produces *intrusive structures*) and lava (which produces *extrusive structures*)

Individually or in small groups, the students create physical representations of diastrophism and volcanism using various materials.

- *Folding*—Students fold sets of stacked paper towels, cloth towels, or toilet paper to demonstrate upfolds (*anticlines*) and downfolds (*synclines*). They use modeling clay, layered with different colors, to create models of folded mountains such as those in northwestern New Jersey.
- *Faulting*—Using templates of fault blocks, they construct *footwall* blocks and *hanging-wall blocks*. They simulate movements of these blocks that result in normal *faults, reverse faults, horsts and grabens, fault block mountains*, etc.
- *Volcanism*—Using templates obtained from the U.S. Geological Survey, they build a model of a typical *stratovolcano* such as Mount Saint Helens.

Students tie all work to real-life examples by researching the impact of earthquakes (a result of movement along fault lines) and volcanic eruptions on the life of the individuals who experience them. What happened to people during and after the recent earthquakes in California or volcanic eruptions? Have events of this nature ever occurred in New Jersey?

Related Science Standards: 1, 2
Related Workplace Readiness Standards: 1.1, 2.2, 2.6, 3.1, 4.2

Finding the Epicenter. To simulate the way scientists use seismographic information, students plot data from a single identified earthquake. They indicate the location of the earthquake epicenter and the arrival time of the resulting P (*primary*) and S (*shear*) waves at seismic stations around the Earth. Using computer graphing or spreadsheet software, students construct a graph of travel time versus distance from the epicenter. They identify the relationship between distance from an epicenter and the arrival times of P and S waves.

Next, using seismograph data from three observing stations for an earthquake for which the epicenter is not specified, students calculate the distance to the possible epicenter for each observing station. The three distances define the radii of three circles centered on the observing stations (one circle for each station). Using the circles and a globe, students find the epicenter of the earthquake. If historic data rather than simulated data is used, students can research published information regarding the earthquake, its location, and any significant surface effects it may have produced.

Related Science Standards: 2, 4, 5
Related Workplace Readiness Standards: 1.1, 2.2, 2.6, 3.1, 3.2, 4.2

Indicator 9: Monitor local weather conditions and changes in the atmosphere that lead to weather systems.

LEARNING ACTIVITIES: Grades 5-6

Weather Journal. Students create daily journal entries of weather observations. They look out the window or step outdoors and make actual observations of weather phenomena. They record readings from a classroom weather center that includes a barometer, a maximum/minimum thermometer, rain gauge, a psychrometer, cloud charts, wind gauge, and wind vane. (Some of these instruments may be handcrafted.) Students can set up computer spreadsheets to make journal entries electronically.

As the year progresses, students discuss weather systems such as *highs* and *lows*. Students review their journals looking for patterns of temperature, pressure, and wind direction changes that match the descriptions of highs and lows. They relate their conclusions to the actual weather conditions that they recorded at those times. Students again review their journal entries to study *seasonal* weather conditions. Ask them to describe typical fall readings, winter readings, and spring readings.

Related Science Standards: 1, 2
Related Workplace Readiness Standards: 2.8, 3.9, 3.12, 4.3, 5.2

Dew and Frost. Students keep records of very local (*micrometeorological*) phenomena such as *dew* and *frost*. In individual journals or a class chart, students record temperature, relative humidity, wind conditions, the presence or absence of cloud cover, and the presence or absence of dew or frost. They use their observations to develop a model for conditions that lead to the formation of dew and frost. Students then use their model—coupled with their own observations as well as information from weather services—to predict when dew or frost may form.

Related Science Standards: 1, 2
Related Workplace Readiness Standards: 2.6, 3.7, 3.12

Internet Weather. Students use the Internet to become familiar with weather around the world. They share weather and climate details with school students in different regions. Project GLOBE is an example of a worldwide initiative that encourages students to gather and share data for scientific research.

Students can plot U.S. weather as a front moves from west to east and then calculate speeds along with changes that occur as the fronts move. For example, students can note the temperatures on various sides of the front. Daily weather maps are available on the Internet.

Related Science Standards: 1, 2, 4, 5
Related Workplace Readiness Standards: 2.2, 2.7, 2.8, 3.1, 3.8, 3.12, 3.13, 3.15, 4.2, 5.4

LEARNING ACTIVITIES: Grades 7-8

Weather Forecasting. Students use local newspapers or download weather maps and data regarding weather conditions from the Internet. They use this information to monitor the progression of air masses and fronts (with their associated weather) across the United States. Students select five major cities such as Seattle, Los Angeles, St. Louis, Boston, and Miami. They create a journal of each city's weather conditions (including temperature, air pressure, wind speed and direction, sky condition, and precipitation). They compare the daily weather maps with each city's weather for the same day. They attempt to identify patterns of passing systems and answer the questions such as

- What weather accompanies a high? a low? a passing cold front? a warm front?
- What is influencing the weather in the chosen cities?

Students can create a school weather forecast, which they post or read over the public address system.

Related Science Standards: 1, 2, 3
Related Workplace Readiness Standards: 1.1, 1.8, 2.3, 3.9, 4.9

An Approaching Low. Students first learn about the formation of various weather fronts (e.g., warm, cold, stationary, and occluded fronts), highs and lows, and associated cumuliform and stratiform clouds. They then track the passage of lows and highs across the country for an extended period of time using weather maps they collect from newspapers or download from the Internet (e.g., http://www.weather.com). By associating the position of the low or high, students are able to understand and even predict the weather of major U.S. cities—and of their own city's weather. Then when they observe the clouds overhead, the local temperature, humidity, wind direction, and atmospheric pressure, they might announce to their classmates: "That was a low that just passed" or "We are experiencing the weather associated with a high right now!"

Related Science Standards: 1, 2, 3
Related Workplace Readiness Standards: 1.1, 1.8, 2.3, 3.9, 4.9

Indicator 10: Investigate the composition, cycling, and distribution of the world's oceans and other naturally occurring sources of water.

LEARNING ACTIVITIES: Grades 5-6

Density Currents. In this activity, students simulate density currents, the up-and-down movement in the oceans that are generated by differences in temperature and/or salinity. First, they place tepid water in a plastic shoebox to a depth of 6 cm. Next, they insert pushpins midway up the sides of two 3-oz paper cups. They fill one cup with ice water colored by several drops of blue food coloring and fill the other cup with hot water colored by several red food drops. The students place the cups in the "ocean" with the pins facing each other and gently pull the pins out. The students observe the resulting currents for several minutes and sketch their observations after each minute. Students repeat the action with a new ocean, fresh water in one cup, and very salty water in another cup. After they pull the pins from the cups, they observe the new currents as before.

Students summarize their work and relate their observations to real-life examples.

Related Science Standards: 1, 2
Related Workplace Readiness Standards: 1.1, 2.3, 3.1, 3.2, 3.7, 4.2, 4.3, 4.9, 5.3, 5.4

Upwelling and Downwelling. Using resources such as articles, books, videotapes, CD-ROMs, videodiscs, and Internet access, students investigate the influence of persistent winds, the Earth's rotation, and shoreline orientation on coastal *upwelling* and *downwelling*. They research the impact of upwelling and downwelling on the climate, weather, and fishing industries of the west coasts of Africa and the American continents.

Next, students simulate these concepts. They create a model of the ocean basin on a sheet of paper. Windows cut out of this top sheet allow a specially designed "wheel" to turn below and relate wind directions to coastal upwelling or downwelling above and below the equator. Students summarize their discoveries through charts, posters, oral or written reports, or multimedia presentations.

Related Science Standards: 1, 2
Related Workplace Readiness Standards: 1.1, 2.3, 3.1, 3.2, 3.7, 4.2, 4.3, 4.9, 5.3, 5.4

LEARNING ACTIVITIES: Grades 7-8

Ocean Surface Currents. The surface currents of the major oceans flow in large circular patterns (gyres) that are very similar to the constant wind patterns that generate these currents. Using printed materials, CD-ROMs, videodiscs, videotapes, and other sources, students review how gyres play an important role in redistributing heat from the lower latitudes to higher latitudes, thereby influencing air temperature, weather, climate, world exploration, and commerce.

Next, students simulate the influence of the wind on ocean currents by filling a clear, shallow container (such as a glass pie plate) with water. They sprinkle paper circles (hole punches or confetti) on the still surface. They each practice creating clockwise and counterclockwise gyres by gently blowing through soda straws. They hold the straws at a very low angle—barely touching the water's surface. Then, groups of two, three, or four students practice generating more than one gyre in the same container. Give each group an outline map of the world's oceans that has the prevailing winds upon it. Students place the dish over the map and attempt to simulate currents influenced by the indicated winds. Withdrawing the dish, students sketch in the ocean currents and match their work to the patterns discovered in their original review.

Related Science Standards: 1, 2
Related Workplace Readiness Standards: 1.1, 2.3, 3.1, 3.2, 3.7, 4.2, 4.3, 4.9, 5.3, 5.4

Seawater Composition. To help visualize the composition of seawater, students weigh out samples of chemical compounds that could be extracted from seawater (e.g., sodium chloride, potassium chloride, calcium chloride, and magnesium sulfate).

- They first calculate the volume of their classroom.
- Using data on the percent composition of seawater, they calculate the weights of each compound that would be present in a "tank" of seawater the size of the classroom.
- They then weigh out the calculated masses of these compounds.

Students research the properties and applications of these compounds that provide the ions typically found in seawater. They can also investigate the challenges of desalination.

Students follow safety procedures and learn to use the safety equipment required when working with chemical compounds.

Related Science Standards: 2, 5, 8
Related Workplace Readiness Standards: 3.2, 3.5, 5.5, 5.7

LEARNING ACTIVITIES: Grades 9-12

Ice Bubbles. Students read about how ice cores are extracted and how the layers are dated. They review data on the composition of air bubbles (especially carbon dioxide) from ice cores. They then graph the data and write a description of changes in the atmosphere over the time intervals represented by the core samples. With this background, they can evaluate information about the "greenhouse effect" that they find in magazine and newspaper articles and television programs. They can visit global warming Web Sites for additional information to use in a debate on whether global warming is or is not occurring today.

Related Science Standards: 2, 5, 12
Related Workplace Readiness Standards: 2.6, 2.9, 3.5, 3.12

Stratigraphy. Stratigraphers look at cross sections of earth as revealed in rock layers such as those exposed in water gaps like the Delaware Water Gap or highway cuts like those on Route 23 in Sussex County. These layers tell a story about the geologic history of the area. Before visiting a site like these examples, distribute stratigraphic cross sections of locations in the United States. "Walk" students through an analysis and then turn them loose on other examples. Challenge them to identify the oldest layer—and the youngest.

Then take students to a site in New Jersey. While there, they sketch, photograph, or record pictorially a cross section of that spot. Back in the classroom, they interpret what they saw individually and in group discussion. Unconformities, top and bottom features, and the influence of folding, faulting, and volcanism all add complexity to the analysis.

Sedimentation. Students observe patterns of sedimentation by using sedimentation tubes and a mixture of fine, medium, and coarse sediment. After they add the sediments to water in the tube, they shake and observe the settling. Ask them to answer the following questions: What size particles settled out first? Which settled out last? Why?

Related Science Standards: 2, 5
Related Workplace Readiness Standards: 1.2, 3.2, 3.7, 3.9

Indicator 12: Use the theory of plate tectonics to explain the relationship among earthquakes, volcanoes, mid-ocean ridges, and deep sea trenches.

LEARNING ACTIVITIES: Grades 9-12

Plate Puzzle. In this activity, students recognize the close relationship of earthquakes and volcanic events to the edges of the Earth's crust known as plates. After reviewing the major crustal plates, distribute picture puzzle pieces that (when assembled) become a world map with the plate edges evident. Students use printed materials, CD-ROMs, videodiscs, and computer simulations at cooperative learning centers to investigate the behavior of the Earth's crust at these plate edges. Challenge them to answer the following questions:

- What happens where plates converge?
- What happens where they diverge?
- How do these behaviors relate to volcanic and earthquake activity?

Students access real-time information about earthquakes from Internet sites. On a large wall map, they place pushpins at locations revealed by the Internet addresses, using one color for earthquakes and another color for volcanic eruptions. If the map is left posted for an extended period of time (perhaps years), the pushpins marking action at these plate boundaries will outline the plate edges. The plates will become more and more recognizable.

Related Science Standards: 2, 3, 5
Related Workplace Readiness Standards: 2.1, 2.3, 3.2, 3.12, 4.1

Plate Edges. Because plates are not directly observable, students work with data that illustrate and support the plate tectonics theory. Provide students with the latitude, longitude, and magnitude data for major earthquakes occurring over the last 50 to 75 years. Students plot the location and magnitude of these earthquakes on a world map and identify a pattern in the distribution of such earthquakes. They try to explain any pattern they see. Students may collect images of geological features from the areas where quake frequency is high.

Students then mark the locations of significant volcanic activity on the world map. They explain how contemporary geologic events indicate the existence of tectonic plates.

Related Science Standards: 2, 3, 5
Related Workplace Readiness Standards: 2.6, 3.2, 3.5, 3.9

Indicator 13: Explore how weather phenomena and human activity are interrelated.

LEARNING ACTIVITIES: Grades 9-12

Snow Removal. Everyone always talks about the weather, but some people have to do something about it; they have to remove snow from roads.

Students search almanacs and databases of weather records to locate historical snowfall data, preferably by monthly accumulation. Then they graph the data. Next, they locate local municipal, or county budget records and identify the annual cost of snow removal for the local municipality. They can plot the snow removal costs on the same graph as the snowfall data. Students relate annual snowfall to the annual cost of snow removal over a several-year period.

Challenge the students to find and account for unexpected shifts in budgeting.

Related Science Standards: 2, 4, 5
Related Workplace Readiness Standards: 2.6, 3.5, 3.9, 3.12

Hurricanes and Major Storms. Excellent videotapes from many commercial sources depict hurricanes, tornadoes, winter storms such as northeasters, and other major weather happenings. Even Hollywood with "Twister" provides the hook to ensnare student interest. Use videos to introduce the nature of these storms. What is a tornado? hurricane? northeaster? a low?

Follow this discussion with specific studies of major weather events.

- Students role-play as weatherpersons with the National Hurricane Center and track hurricanes such as Andrew or Gordon. Using NOAA hurricane tracking maps, students plot 24 hours of information at a time. At the end of each 24-hour period they issue watches and warnings and attempt to predict an approximate landfall. Should areas be evacuated? This is a multimillion dollar decision! Andrew is quite predictable, but the wandering path of Gordon will challenge students. When landfall actually occurs, students research the financial and human losses incurred. What happened at the point of landfall? How widespread were the losses? Were human lives lost? What happened to wildlife habitats?

- Using NOAA's data for major storms, students plot the path of major northeasters such as the Storm of the Century (1993) or the Blizzard of (1996). The position of the track in relation to the Atlantic Ocean and the eastern coastline dictates snow depths. Students record snow depths at different locations on a surface map of the eastern United States. Adding isolines at intervals helps students see the relationship of the storm track to the total snowfall.

Through written reports or multimedia presentations, students describe meteorological events and the serious impact such phenomena have on all facets of human experience.

Related Science Standards: 1, 2, 4, 5
Related Workplace Readiness Standards: 1.5, 1.7, 2.1, 2.10, 3.1-3.3, 3.11, 4.5, 4.6, 4.7, 4.9

Indicator 14: Identify and explain factors that influence water quality needed to sustain life.

LEARNING ACTIVITIES: Grades 9-12

Water Quality. Students plan a trip to a local water treatment plant or a sewage treatment plant to learn about water quality and its relation to the quality of human life.

Students conduct a long-term study of water quality. They periodically sample the pH, temperature, dissolved oxygen, and CO_2 content of a nearby river, stream, lake, or of the ocean. The class divides into teams, each with specific responsibilities. Explain to each group the appropriate scientific protocol related to their task or have the students download protocols found at the *Project GLOBE* Web site. Obtain test kits for field and classroom studies of both qualitative and quantitative measures of water samples from scientific supply houses.

Students use computers to record, store, and present their findings.

Related Science Standards: 2, 4, 5, 8
Related Workplace Readiness Standards: 1.3, 1.7, 2.4, 2.7-2.9, 3.1-3.15, 4.1, 4.2, 4.7, 5.7

Nonpoint Source Pollution. In a field study of nonpoint source water pollution, students begin by examining school property for evidence of this type of pollution. They look for runoff from parking lots, lawns, and playing fields. They organize their data by the type of pollutant that may be present and its estimated quantity. Later, they identify how nonpoint source pollutants enter the water cycle in the local community. They develop a community map showing where this pollution begins to concentrate in noticeable levels.

Students trace the effects of nonpoint source pollutants on area rivers, estuaries, and the ocean. Challenge them to propose realistic approaches for reducing this type of water pollution.

Related Science Standards: 2, 5
Related Workplace Readiness Standards: 3.7, 3.8, 3.11, 3.13, 4.2